PUBLIC DOCUMENT No. 1

NINTH ANNUAL REPORT

OF THE

NORTH DAKOTA

AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL COLLEGE, N. D.,

TO THE

GOVERNOR OF NORTH DAKOTA

FEBRUARY 1, 1899

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LETTER OF TRANSMISSAL.

FARGO, N. D., February 1st, 1899.

To His Excellency Governor F. B. Fancher,
Governor of the State of North Dakota:

Sir: As required by act of congress, approved March 2, 1887, and section 13, chapter 160 of the Laws of 1890, for North Dakota, I hereby submit the Ninth Annual Report of the North Dakota Agricultural Experimental Station for the year ending February 1st, 1899, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30th, 1898.

Very respectfully yours,
W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experimental Station:

Gentlemen: I have the honor to submit to you the Ninth Annual Report of the Experiment Station.

The reports made to me by the heads of the several departments have been materially abbreviated but are intended to embody the experiments and investigations of the past year. Four bulletins were published during the year.

No. 31, by the director, embracing Experiment Station Notes on Miscellaneous Subjects.

No. 32, by Professor E. F. Ladd, (1) Drinking Waters; (2) Wool Scouring; (3) Soil Humus; (4) Analysis of Foods; (5) Vinegars.

No. 33, by Professor J. H. Sheppard, Fattening Cattle; Barley vs. Bran and Shorts.

No. 34, Professor C. B. Waldron, Injurious Insects of the State with Methods of Treatment.

This report contains much interesting matter for the farmers and stockmen of the state, of sufficient importance but not of sufficient length to be published in bulletin form, and yet too valuable to be entirely overlooked.

The period embraced in this report has been a busy one and several bulletins are now nearly ready for the press that will cover investigations made during the season of 1898.

Very respectfully,

J. H. WORST, Director.

CHEMICAL DEPARTMENT.

To Director J. H. Worst:

Sir: In presenting my Ninth Annual Report as chemist of the Experiment Station I submit in the main only a synopsis of the work of the department, leaving the fuller details and extended report for bulletins. During the past year one bulletin has been prepared and published under direction of this department. Five topics were discussed in this bulletin, namely:

1st, Drinking Waters.
2nd, Wool Scouring.
3rd, Soil Humus.
4th, Analysis of Foods.
5th, Vinegars.

From date presented regarding waters suitable for drinking purposes the following conclusions were drawn:

1. The water supply for towns should not contain large quantities of solids. According to Dr. Smart waters are desirable that contains not to exceed three hundred parts, and are to be condemned when they exceed one thousand parts per million. Taking these figures as a basis, it would seem that 500 parts per million would be as high as is permissable for good health, and this would agree closely with Wanklyn's standard. If we take 500 as a standard of purity for solids, then but few, if any, of the waters in the deep artesian wells of the state could be recommended for drinking purposes.

2. If the kidneys must eliminate the excess of soluble mineral salts then the continuous use of these artesian waters might result in kidney trouble if not in gastric disturbance, especially if one was predisposed to kidney troubles. Several complaints have been made that such a condition prevailed among the users of these waters.

3. The presence of organic matter in the deep well waters of the state is not to be considered as an indication of sewerage contamination.

4. The chemist can give you but little assistance in interpreting the result of water analysis unless he knows the conditions surrounding the well or water supply.

In scouring wool it was found that for three carload lots there was a shrinkage in weight from scouring the wool of 61.47 per cent. Under the topic of Soil Humus considerable data is presented to show that the fertility of a soil depends to a considerable extent upon the amount and condition of the humus contained in the soil, that the available phosphoric acid and other mineral con-

stitutents bear some relation to humus conditions and that a minimum amount of organic matter in the soil exists as an essential for different classes of grain. The following conclusions were drawn from the data presented.

1. By twenty years of wheat growing from 40 to 60 per cent of the organic matter of our soils have been lost.

2. For every pound of organic matter that has gone to furnish its nitrogen to wheat, five pounds have been lost.

3. Many of our soils that originally contained from 8,000 to 10,000 pounds of nitrogen per acre to the depth of one foot now contain from 3,000 to 6,000 pounds

4. By the loss of humus our soils have become less retentive of moisture and give it up by evaporation sooner than when they were well supplied with humus.

5. Bare summer fallowing and burning of the wheat stubble destroys large quantities of organic matter and humates.

6. To keep the supply of humus in the soil we must imitate nature, and grow for the present at least one year in five a grass crop on our land.

7. By keeping up the supply of humus in the soil, the crop will feel the effects of drought less than in soils poor in humus.

8. Clover would be an ideal crop to maintain the humus in the soil and to aid in collecting nitrogen from the air, but grass will serve the purpose of supply humus, and Bromus inermis has done well in this state, and may be used.

Under vinegars evidence was presented to show that vinegars are being sold as cider vinegars which in reality were not made from the juice of the apple.

Since July last I have had the help of an assistant, Mr. Hugh McGuigan, who has performed faithfully the work entrusted to him and to whom much credit is due for data presented in this report. The lack of proper laboratory room has made it impossible to carry out many lines or research that we had hoped to be able to undertake.

During the past year we have investigated more fully the relation of humus and humates to soil fertility and in this connection a large amount of analytic A 1 work has been necessary, the chemistry of the waters of the state have been more fully investigated, experiments have been carried out in connection with farmers in the south part of the state in growing sugar beets and chicory and a more complete record of meteorological conditions has been secured. Much routine work has been undertaken to benefit the farmers, and several minor experiments carried out to answer some questions of benefits to farms. Perhaps for the direct and immediate benefit of the farmers one of the most important results was that of the following case:

THE POISONING OF CATTLE.

In which it was demonstrated that the animal was poisoned by

eating "slough" hay containing water hemlock. It is further probable that many other cases of similar nature have been due to the same cause. A bulletin will soon be issued giving full information for the benefit of farmers and stockmen.

AN ACTIVE PRINCIPLE IN MILLET HAY.

Another important determination is that there exists in millet hay an active principle—a glucoside, that produces marked physiological action upon animals and is the probable cause of the trouble sometimes arising from the exclusive feeding of this hay to horses and cattle.

SUGAR BEETS.

The year's experiment carried out with growing sugar beets in connection with farmers in the south part of the state has shown that beets of good quality can be grown in this locality. The average of our results for 1898 shows the beets to contain 14.38 per cent of sugar with co-efficient of purity of 79.4 per cent, a much better showing than for many localities where factories are now operating. The maximum per cent of sugar was 20.20.

CHICORY.

Experiments among fifty farmers have demonstrated that chicory of superior quality can be grown in the south part of the state, and as a factory for working up the chicory does not require an expensive plant there is no reason why this industry might not be profitably introduced.

MARL.

Two samples of marl were sent in by Mr. F. W. Iddings, Grand Forks, for determination of nitrogen. The dry substance was found to contain:

	No. 1.	No. 2.
Nitrogen, per cent	1.21	0.83

No. 1 was taken from a depth of eight feet, and No. 2 a depth of twenty feet below the surface of the ground.

PRESERVING EGGS.

Experiments have been made in methods of preserving eggs and it has been found that a solution of water glass preserves eggs for several months with very little deterioation in quality. Full data as to methods will be presented in a bulletin now ready for the printer.

THE CHEMISTRY OF THE RIPENING OF CREAM.

During the past summer considerable work has been done to determine some of the chemical changes that take place during the process of ripening cream preparatory to the churning.

In the following we shall consider only that portion of the cream known as nitrogeneous or the proteids. Samples of cream as fresh as could be procured, at most but a few hours old, were examined and again other samples taken after the cream had become well

ripened and somewhat acid and these subjected to analysis by the same methods.

Those who may desire to follow the details of our work, and to know the methods employed are referred to an article on "The Proteids of Cream,"* as the general results only are given here. The following shows the per cent of nitrogen for both the samples of fresh cream and the ripened product:

	Fresh Cream.	Ripened Cream.
Casein nitrogen	0.237	0.249
Albumen nitrogen	0.035	0.027
Albumose nitrogen	0.031	0.033
Peptone nitrogen	0.023	0.032
Total nitrogen	0.326	0.341
Nitrogen in cream	0.335	0.344
Per cent of loss	0.009	0.003

Many determinations were made and with the same general results as for the examples given above. The loss was not very great in the process of separation, and further there does not seem to be any great change in the proteids during the process of ripening. In one respect, however, there seems to be quite a marked difference in the general appearance and properties. The casein as precipitated from the fresh cream and that from the ripened cream seems to possess many properties quite different in the two cases. Experiments are now in progress to determine this difference, also other points in regard to the chemistry of ripening cream.

SOME STUDIES IN METEOROLOGY.

The records of this station have been continuous since August 1891, for temperature and rainfall, and since April, 1892, for soil temperatures. The amount of data accumulated during this time is large and it is proposed in this connection to give some of the means in the various lines where observation have been carried on. That such data may prove interesting and perhaps valuable is shown from a lack of knowledge of the true climatic and soil conditions existing in the Red River Valley, as instanced in several English journals of agriculture and even asserted in some American journals regarding the condition of North Dakota soil. They have asserted that with the small amount of rainfall in the wheat belt of North Dakota that wheat could only be grown because of the great depth to which the ground froze in winter, and its slow and gradual thawing in the summer, and so furnishing a limited supply of water to the growing crop of wheat. From some of these writings it might be inferred that the ground was never wholly free from frost.

To learn just what were the true conditions, and further to see what relation could be traced between climatic conditions of air and soil and the wheat yield, has been the object of this study and the compiling of the large amount of data therefor.

*Journal of the American Chemical Society, Vol. 20, p. 858.

DEPTH TO WHICH THE GROUND FREEZES.

Soil thermometers from one inch to eight feet in depth placed in an open field furnish the means of determining the soil temperatures. These thermometers are of standard make designed by the late Dr. Sturtevant for use at the New York State Experiment Station and made by H. J. Green of Brooklyn, N. Y. The following shows the lowest temperatures reached by the thermometers at from three to eight feet in depth during the several winter months and usually the minumim temperature was recorded during the month of March:

	3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.
1893..	30	32	33	33.5	35	36
1894....	....	31.5	33	34.0	35.5	37
1895..	25	30	32	33.5	35	36.5
1896....	27.5	30	33	34.0	36	38
1897..	28.5	31.5	33	34	35	....

Only one winter, 1895, did the frost line reach down five feet, but each year it passed below four feet as shown by the readings taken once a week during the winter. From April to November readings were taken three times daily.

From the above data we may conclude then that the ground freezes to between four and five feet in the open field during the winter months.

AT WHAT DATE IS THE FROST OUT OF THE GROUND?

We find that the average midday soil temperature for May during the several years to have been:

SOIL TEMPERATURES FOR MAY.

Depth of Thermometer. Inches.	1892	1893	1894	1895	1896	1897	1898
1..	48.3	52.3	58.1	62.0	59.5	60.0	56.5
6....	41.7	42.6	49.2	50.5	51.4	45.7	46.8
12..	39.4	38.9	47.2	48.1	47.6	43.5	43.0
24....	34.9	33.3	43.5	43.1	41.2	37.7	37.8
48..	31.7	32.0	37.3	36.7	54.9	33.4	34.3

The results given in the last table shows that the frost was out of the ground sometime in May each year with the possible exception of 1892-3, but this table does not show how early in May this may have been. By dividing the month into three periods—the first ten days, the second ten days and the last eleven days and taking the

average of the readings for each of these midday periods, we may gain some knowledge of the real conditions. Such data is presented in the following:

SOIL TEMPERATURES FOR MAY.

Ten Day Periods.	1 In.	6 In.	12 In.	24 In.	48 In.
1892.					
1—10	41.6	36.9	35.5	32.3	31.5
11—20	48.6	42.9	40.2	34.9	31.7
21—31	54.3	45.0	42.2	37.4	35.2
1893.					
1—10	49.7	38.7	34.4	31.5	32.0
11—20	53.1	44.5	40.4	32.8	32.0
21—31	54.3	44.7	41.8	35.6	32.0
1894.					
1—10	51.6	44.2	42.1	38.4	32.8
11—20	60.7	60.5	47.8	43.9	37.4
21—31	61.9	52.7	52.0	48.0	42.0
1895.					
1—10	66.2	53.0	46.2	40.7	32.0
11—20	56.1	46.6	46.4	43.4	37.7
21—31	63.7	52.1	49.5	45.2	40.7
1896.					
1—10	62.7	51.0	44.7	35.6	31.5
11—20	56.7	50.9	48.4	43.0	34.1
21—31	59.6	52.6	49.8	45.4	39.7
1897.					
1—10	63.2	46.4	42.2	34.3	32.1
11—20	58.6	46.7	42.9	37.2	32.1
21—31	58.6	48.1	46.0	41.6	36.0
1898.					
1—10	54.9	41.3	38.4	33.1	32.0
11—20	58.0	45.7	42.2	36.8	32.8
21—31	60.1	52.1	48.2	43.2	38.0

With the exception 1893 the frost was all out of the ground by the 20th day of May, so that it cannot be said that the frozen ground gradually thawing during the summer months is the source of moisture to supply the growing crop of wheat. Rather the necessary supply of water to insure a good wheat yield is either from

the stored up moisture in the soil or from a sufficient rainfall during the growing season. We have already shown* that the Red River Valley soils have the power of holding large quantities of water but to this point we shall refer again farther along.

In considering the soil temperatures as we have been, it may be helpful at this point to give the mean monthly temperatures of the soil for various depths from May to November as recorded for the several years at this station. Such data is presented in the accompanying table.

MEAN MONTHLY MIDDAY SOIL TEMPERATURES.

Depth of Thermometer in Inches

May.	1	3	6	12	24	48	60	84
1892.. .	48.3	44.1	41.7	39.4	34.9	31.7	32.3	34.0
1893. ..	52.3	46.3	42.6	38.9	33.3	32.0	33.0	35.0
1894.. .	58.1	52.1	49.2	47.2	43.5	37.3	35.8	35.8
1895. ..	62.0	54.2	50.5	48.1	43.1	36.7	33.5	35.2
1896.. .	59.5	55.3	51.4	47.6	41.2	34.9	34.2	34.4
1897. ..	60.0	53.3	45.7	43.5	37.7	33.4	33.5	34.4
1898.. .	56.5	....	46.8	43.0	37.8	34.3	34.1	34.8
Mean. .	56.6	50.8	46.8	43.9	38.7	34.3	33.7	34.8
June.								
1892.. .	66.5	60.6	56.7	53.9	47.5	38.3	36.5	35.3
1893. ..	69.6	63.0	59.4	55.6	48.4	39.4	36.4	36.0
1894.. .	71.5	65.2	62.1	60.1	54.8	48.3	44.5	40.3
1895. ..	66.0	60.5	57.8	56.9	53.7	46.5	43.1	39.9
1896.. .	65.1	62.2	59.6	57.3	52.5	46.3	42.9	38.9
1897. ..	63.4	60.4	56.5	53.6	49.0	43.6	40.3	37.6
1898.. .	67.4	....	59.4	56.4	51.7	45.7	43.1	38.1
Mean. .	67.0	61.9	58.8	57.6	51.0	44.0	40.9	38.0
July.								
1892.. .	75.0	67.9	65.1	62.6	57.8	49.9	46.5	41.6
1893. ..	74.9	68.4	64.9	63.9	58.4	53.9	47.4	42.2
1894. ..	72.4	68.4	66.6	65.3	62.4	55.5	51.8	45.6
1895.. .	71.2	65.4	63.6	62.6	58.4	52.9	49.1	44.2
1896. ..	75.9	68.8	64.8	63.1	59.5	53.7	51.5	44.3
1897. ..	72.0	68.6	66.1	63.9	59.0	52.7	48.6	42.8
1898.. .	77.0	....	65.6	63.9	59.6	53.4	49.4	43.8

*Bulletin No. 24—North Dakota Soils.

Mean. .	74.1	67.9	65.2	63.6	59.3	53.1	49.1	43.7
Aug.								
1892.. .	72.4	64.4	64.2	64.0	61.1	55.0	52.2	46.6
1893. ..	77.0	66.8	64.3	63.7	60.9	55.0	52.3	47.0
1894.. .	75.0	65.2	65.3	64.8	63.3	57.8	54.5	49.3
1895. ..	77.8	66.4	63.5	63.2	60.6	56.1	53.0	46.6
1896.. .	76.5	68.1	67.3	63.2	60.6	56.5	53.3	48.1
1897. ..	72.7	66.3	63.3	62.8	60.4	55.6	52.3	46.8
1898.. .	78.1	....	64.0	63.4	60.9	56.5	53.1	47.5
Mean. .	75.6	66.2	64.5	63.5	61.0	56.0	52.9	47.4
Sept.								
1892. ..	65.6	59.5	57.4	58.0	57.1	54.7	53.1	49.3
1893.. .	66.9	59.4	57.9	58.7	57.9	54.9	53.2	49.1
1894. ..	69.8	61.1	58.3	58.1	58.7	57.0	55.1	51.1
1895.. .	69.2	60.4	57.1	58.8	58.1	55.8	53.8	59.2
1896. ..	60.1	56.1	53.9	55.7	55.9	54.9	53.3	49.9
1897.. .	72.6	66.0	61.4	61.3	59.7	56.7	54.2	49.3
1898. ..	65.5	....	57.6	58.3	57.8	55.9	53.7	49.7
Mean. .	67.1	60.4	57.5	58.4	57.8	55.7	53.9	49.6
Oct.								
1892.. .	54.6	49.7	49.3	51.8	52.8	52.8	52.0	49.9
1893. ..	47.2	44.0	44.5	46.6	47.1	50.2	50.1	48.7
1894.. .	42.0	45.1	45.6	47.3	48.6	50.9	51.2	50.2
1895.. .	53.2	45.6	45.6	47.4	49.5	50.1	50.8	49.4
1896. ..	46.8	40.2	43.8	46.5	48.5	50.2	50.1	48.8
1897.. .	50.6	50.3	49.8	52.2	53.0	53.7	52.9	50.3
1898. ..	46.2	....	45.0	47.7	49.7	51.7	51.4	49.4
Mean. .	48.6	45.8	46.2	48.5	49.8	51.3	51.2	49.5

The means for the several years brought together by months show several points of interest in the soil study as presented in the accompanying table.

MEAN MONTHLY TEMPERATURES FOR SEVEN YEARS.

Means for Month	1 In.	3 In.	6 In.	12 In.	24 In.	48 In.	60 In.	84 In.
May ..	56.6	50.8	46.8	43.9	38.7	34.3	33.7	34.8
June ..	67.0	61.9	58.8	57.6	51.0	44.0	40.9	38.0
July ..	74.1	67.9	65.2	63.6	59.3	53.1	49.1	43.7
Aug. ..	75.6	66.2	64.5	63.5	61.0	56.0	52.9	47.4
Sept. .	67.1	60.4	57.5	58.4	57.8	55.7	53.9	49.6
Oct. ..	48.6	45.8	46.2	48.5	49.8	51.3	51.2	49.5

An inspection of the above table shows the one inch thermometer to give the highest record in August, while the soil at three, six and twelve inches reaches its maximum temperature in July, the soil at twenty-four and forty-eight inches reaches an average maximum in August the same as for the surface soil at one inch in depth, while the soils at a depth of sixty and eighty-four inches continued to grow warmer and reached their maximum temperature in September.

SOIL TEMPERATURES IN NORTH DAKOTA AND NEW YORK COMPARED.

It will be interesting to know how the soil temperature of North Dakota compares with other localities. We have made such a comparison with the records taken at the station at Geneva, New York, with similar instruments and under like conditions with those at this station at the depth of one, three, six and nine inches for the summer of 1896* using the midday temperatures as heretofore.

SOIL TEMPERATURES.

1896.	1 In.	3 In.	6 In.	9 In.
June.				
Fargo	65.1	62.2	59.6	58.6
New York	67.3	66.5	65.5	65.0
July.				
Fargo	75.9	68.8	64.8	64.0
New York	76.6	72.4	69.3	67.8
August.				
Fargo	76.5	68.1	67.3	63.6
New York	73.2	70.8	69.3	68.3
September				
Fargo	60.1	56.1	53.9	55.5
New York	64.0	63.1	62.1	61.2

When it is considered that Geneva, New York, is about 300 miles farther south than Fargo we find less difference in the soil temperature, especially for the surface soil, than might have been anticipated. The records for May are not presented, as none are given for New York. It is evident then from the foregoing that the plant in North Dakota does not have to contend with a much different soil temperature than is the case for plants in New York.

ATMOSPHERIC TEMPERATURE.

Having now considered the soil temperature we may briefly summarize the mean of the air temperatures as found at this station for the past seven years.

* The records for New York are taken from the 15th Report of the Station at Geneva.

MEAN MONTHLY TEMPERATURE.

Months.	1892	1893	1894	1895	1896	1897	1898	Mean Seven Years.
January	3.7	-3.0	-2.6	-4.4	4.3	-0.8	14.0	1.6
February	11.4	-1.4	6.2	1.2	10.6	5.0	10.2	6.2
March	25.0	10.9	26.4	22.1	12.4	10.4	24.0	10.7
April	39.9	32.6	42.3	49.2	42.0	37.5	51.5	40.7
May	50.4	51.8	55.2	55.0	63.2	54.8	53.0	54.8
June	67.0	70.1	69.0	61.0	70.9	61.8	61.5	65.9
July	72.8	68.1	69.8	65.0	67.7	69.4	68.0	68.7
August	70.8	65.4	67.1	64.1	65.2	65.9	65.2	66.2
September	63.0	56.7	58.2	57.6	53.8	66.9	57.8	59.1
October	47.1	39.3	43.6	39.8	41.4	46.3	....	....
November	20.0	20.8	22.1	22.2	8.6	21.4	....	....
December	5.4	1.7	19.4	12.2	12.6	6.5	....	....

The mean summer temperature from June to September during the growing period is not very much below that of Western New York, but for the month of May we have a lower temperature averaging 54.8, but averaging considerable above this for the last half of the month.

AMOUNT OF RAINFALL.

Our records have been continuous for rainfall since August, 1891, and in the following table we present a record of the monthly rainfall for the several years.

PRECIPITATION BY MONTHS.

Months.	1891	1892	1893	1894	1895	1896	1897	1898	Av'ge Six Years.
January	....	0.04	0.23	0.09	0.36	0.16	0.36	0.06	0.18
February	....	0.18	0.11	0.09	0.12	0.06	0.77	0.10	0.22
March	....	0.97	0.71	1.29	0.00	0.48	0.96	0.34	0.68
April	....	2.42	2.63	3.35	1.36	3.64	0.89	0.88	2.19
May	....	3.88	0.77	2.62	1.62	4.70	0.74	3.99	2.62
June	....	1.93	3.62	6.23	5.61	2.41	7.10	2.25	4.17
July	....	5.02	2.21	0.80	3.24	0.91	8.24	2.59	3.28
August	2.69	4.03	2.72	1.17	1.59	2.17	0.77	2.84	2.57
September	2.69	1.39	0.87	0.56	1.55	2.58	0.57	1.23	1.63
October	0.72	0.25	0.90	2.11	0.14	1.96	1.81	1.62	1.36
November	0.46	0.50	1.00	0.29	1.16	0.70	0.25	.08	0.62
December	0.40	0.12	0.41	0.12	0.10	0.26	0.04	.22	0.21
Totals	....	20.73	16.17	18.72	16.85	20.09	22.50	16.20	19.72

An inspection of the foregoing table shows June to be the month of average greatest rainfall with July coming next. With an annual rainfall at Fargo of nineteen and three-fourths inches, an average of 16.46 inches of this falls from April to September, inclusive, or during the time the growing crops stand most in need of it. This leaves an average of 3.26 inches rainfall for the remaining six months. For the three winter months the average snowfall estimated as rain is but sixty-one hundreths of one inch, or as snow this would be about six inches of average snow fall for the three months, December, January and February.

Since the cultivated soils of the Red River Valley will hold on an average about 72 per cent of their own weight in water before becoming saturated the amount of drainage water must be small during the summer months. An acre of such soil to the depth of one foot, estimated to weigh 3,225,000 pounds (1612 tons), could retain 2,322,000 pounds (1161 tons) of water, or an amount equivalent to a rainfall of 10.26 inches. However, in a heavy rainfall a considerable portion flows away on the surface before it can be absorbed by the soil, this would be more particularly true on grass land and upon the unbroken prairie than upon the well cultivated fields where the water is much more rapidly taken up by the soil. Inasmuch as soils always contain considerable water the additional amount that could be taken up at any one time would be much less.

AMOUNT OF WATER IN THE SOIL.

Determinations of the amount of water in the cultivated soil were made in one of the college fields for May to October, inclusive, during the years 1892 to 1898, inclusive. Samples of soil were taken each week from the surface one to three inches and again from five to seven inches in depth. The average per cent for the five years is shown as follows:

	1892	1893	1894	1895	1896	Av'ge for 5 Years.
May	35.29	30.85	28.07	24.48	29.60	29.66
June	29.65	23.21	18.28	22.04	24.90	23.61
July	27.79	27.82	17.34	22.18	12.27	21.48
August	30.30	21.51	10.50	16.01	16.63	20.19
September	28.44	15.38	11.50	19.03	26.18	20.10
October	19.33	24.30	26.54	16.50	12.16	19.78

Taking the figures as showing the per cent of water in the first foot of soil, then averages for five years would give the total amount per acre to the depth of one foot about as follows:

	Pounds of Water Per Acre.
May	1,359,982
June	996,525
July	880,425
August	853,790
September	812,700
October	793,350

The above figures show a gradual diminution of the amount of water in the soil from early spring until the ground freezes up in the fall.

The facts as herein set forth show that the supply of water for growing crops is derived from the large amount stored up in the soil and of which the soil is very retentive, and further that a large proportion of the annual rainfall comes during the period when the crops are growing and standing in need of it.

In this connection it will be interesting to note the yields per acre for wheat and oats on the college farm for the several years under consideration. In the column headed plots are given the average yield per acre for the four plots in the rotation series which have been continuously in wheat. In the next column is given the average yield of wheat for the entire college farm, also the yield of oats for the farm in the next column, while in the last column is given the average yield of wheat per acre for Cass county for the same periods.

AVERAGE YIELD PER ACRE, BUSHELS.

	Wheat, Blots.	Wheat, Farm.	Oats, Farm.	Wheat, Cass County.
1892	19.4	18.6	36.4	13.32
1893	9.1	13.7	34.6	9.82
1894	18.9	20.7	59.3	13.95
1895	23.4	31.4	50.4	18.93
1896	16.4	12.8	49.5	11.53
1897	13.2	10.5*	39.3	10.48
1898	22.9	24.3	70.5	15.00

For the data from the plots and farm yields I am indebted to Professor Shepperd of the Department of Agriculture, and for the yield of wheat for Cass county I am indebted to Hon. H. U. Thomas, Commissioner of Agriculture and Labor, Bismarck, N. D.

The above data are offered without further comment at the present time, as records for a longer period are necessary before any conclusions may safely be drawn that would have any direct value.

Respectfully submitted,

E. F. Ladd.

* The crop much injured by floods in July. True for all grains for same season.

AGRICULTURAL DEPARTMENT.

To J. H. Worst, Director:

Sir: The work in this department has consisted in a further study of the subjects reported upon a year ago with some modifications, contractions and additions. Grain testing has been reduced while seed breeding with wheat and corn has been given more attention than heretofore. The results obtained from the seed breeding work are very promising. Some of the better kinds developed will soon be increased to sufficient quantity to distribute by sale to the farmers of the state.

The rotation experiments have been continued without interruption. Each year adds more data and the interest in them increases as time goes on.

The influence of barnyard manure has been studied in its effect on soil moisture and crop yield. It has constituted one of the features of the rotation trials and in addition to those plots others have been instituted for further study of its effects. A study of the effect of fresh stable manure upon the flavor of potatoes has constituted one branch of the experiment.

The study of cultivated grasses and some wild or native species which have been partially domisticated has been carried on. Many kinds which are not successful have been thrown out of the trial after suffiicient evidence has accumulated against them. The study of the effect of different small grain nurse crops upon grasses has been continued. Seed of Austrian Brome grass (Bromus inermis) has been placed in all but two counties of the state for trial.

The trials with varieties of potatoes have been continued. Investigation of the methods of seeding and cultivating potatoes has also been continued.

The effect of different methods of cultivation upon the yield of wheat and their effect upon the soil moisture has been given further study. A bulletin containing the results of this trial will soon be ready for publication.

A study of the root system of wheat, oats, flax, corn, potatoes and sugar beets has given some interesting results. An illustrated bulletin giving the details of the results is now nearly ready for the press.

The feeding experiments with horses and mules have been carried forward and have given some interesting results. Mules have been compared with horses when upon light, medium and heavy work. A comparison of barley with oats has constituted a feature of the experiment.

The results of a feeding experiment with steers was published during the past year. The following summary gives the conclusions which this single trial with ten head of cattle and the data obtained from other sources seem to indicate:

1. There is enough grain and mill products in the state to fatten our cattle.

2. That feeding stations can be made a success where a supply of bran and shorts are assured.

3. Cattle can be profitably fattened on corn fodder, hay and barley on nearly all the farms in North Dakota.

4. It is not advisable to feed more than 150 head of cattle in one yard.

5. Grass fat range steers do not compete directly with grain fed steers.

6. Growing corn fodder for roughage makes fewer weeds and heavier yields for following wheat crops.

7. The market demand will probably continue to be good, owing to a scarcity of meat producing animals in the United States.

8. Range steers require a long preliminary feeding before a heavy supply of grain is given them.

9. Eleven hundred fifty pound steers fed for a period of six months will eat an average of about 16¾ pounds of grain and twelve pounds of hay per day.

10. Range steers fed in a commercial way will gain from a pound and a quarter to a pound and a half per day.

11. Cattle should neither be gorged nor starved for feed or water before shipment is made. A medium quantity of dry feed is best.

12. Barley gives a heavier gain per hundred pounds of grain fed and a higher rate of gain per day than does bran and shorts.

13. With the prices for feed which prevailed locally, bran and shorts gave the cheaper gain and the greater profit.

During the year 1898 one hundred thirteen inquiries by letter upon specific agricultural subjects not fully treated in published reports and bulletins have been answered by this department, either by mail or through agricultural journals.

During the season of 1898 I was assisted by A. M. TenEyck, M. S., who did efficient and creditable work.

Respectfully submitted,

J. H. SHEPPERD,
Agriculturalist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

Sir: The following outline will indicate the kind of work which was planned and worked upon during the past year. I have proceeded along essentially the same lines of investigation embodied in the work of previous reports and bulletins. The main field of investigation has been that of the diseases which effect cereal grains.

While the methods proposed for preventing smut in other states have been quite successful for that purpose, it has been useless to propose them for the work here, hence an attempt has been made to obtain a chemical treatment which could be used on an extensive scale without injury. In previous years corrosive sublimate was found to be a very successful preventive for stinking smut of wheat and easy of general application, but like other chemical remedies was more or less injurious to crops of oats or barley.

In 1897, after the preliminary tests in 1896, a 40 per cent solution of formaldehyde was found to be a very effective chemical for the prevention of stinking smut of wheat and loose smut of oats, and advantageous, at least, in the treatment of barley smuts. (See Eighth Annual Report of the Experiment Station, pages 44-49.) In order to ascertain how generally farmers have been accepting advice from the station in these matters, the following circular letter was sent out this past autumn.

"Dear Sir: This station is trying to ascertain how successful the farmers have been in applying the treatments recommended by the station for the prevention of the grain smuts and potato diseases. The Department of Botany is especially interested to know full particulars as to just how the work was done so that a judgment may be made from the replies as to bettering present methods of treatment.

Please answer the following questions:

What crop did you treat?

How extensively?

What method did you use?

With what results?

If successful or unsuccessful, what reasons?

Have you any reason for believing that wheat or oat smut may lie in the ground from one year's crop to another so as to infect the new crop?

Please ask any questions upon such matters as you may desire, and we will, if able, explain.

Yours respectfully,

H. L. BOLLEY, Botanist.

J. H. WORST, Director."

The numerous replies to this and other letters are almost unanimous in the approval of the formalin treatment for prevention of

smuts as first proposed by this station. (See Bulletin No. 27.) Only a very few failed to get satisfactory results in prevention, whether they applied hot water, corrosive sublimate, copper sulphate, or formalin (formaldehyde 40 per cent). It is evident, however, that the last named substance is the favorite, its non-poisonous character and great efficiency commending it as well as the ease with which it may be applied. Furthermore, many have noted the markedly beneficial influence upon the after growth from the seed. Our success has been so satisfactory in making it practical to apply all these different treatments upon the extended scale necessitated by Dakota conditions that the work of simplifying methods has been under further study this year. Because of the fact previously ascertained that is the formaldehyde gas which is effective in the formalin treatment, I have thought it possible that large masses of grain might be subjected to the fumes from evaporated formaldehyde solution. The preliminary investigations have been conducted this year. Details will be retained until future results indicate whether the work is applicable to farm methods. The difficulty encountered in the application so as not to injure the seed. Numerous tests upon small lots of seed exposed dry and damp indicate:

(1) That a treatment upon this plan of fumigation is possible with entire prevention and without detriment to the yield. (2) It is most effective when the grain is damp. (3) Grain is readily entirely killed by the fumes whether treated when dry or damp; hence the method may be more deficient and costly to govern than the present method of spraying. It may, however, be adapted to the use of elevator companies or general seed salesmen. One point I think may be affirmed with surety as finally proved by these experiments; as previously noted for other methods of treatment, one may not hope to prevent the occurrence of *Ustilago tritici (Pers) Jensen*, the *loose smut* of wheat, by means of seed treatment. This disease has appeared in about a uniform percentage of heads in all treatments which the wheat could withstand.

The study of the effects of different dates of seeding and of atmospheric and soil conditions upon the developments of smuts has been continued in numerous tests, this season under irrigation conditions. For a number of years I had observed that *Avena fatua* L. —, the common wild oat, though abundantly attacked by the rust known as *Puccinia graminis Pers.*, always remained free from attacks of smut, *Ustilago avenae (Pers) Jenson*. This seemed worthy of investigation. (1) In 1897 when plants of Avena fatua were in full blossom, the glumes well open, smutted heads of Avena sativa were tied into the panicles of the wild plant so that the spores readily dusted into the open flowers as the wind swayed the plants from day to day. Seed saved from these treated plants were seeded in the experimental garden 1898, resulting in a heavy growth of smut. (2) Seed collected in 1898 were divested of the enclosing glumes and soaked in water containing an abundance of the germinating spores of *Ustilago avenae* for twenty-four hours and

gave as a product about 33 1-3 per cent of smutted plants. Avena fatua is thus susceptible to the attack of that smut. Further observation is necessary to fix the reason for the freedom from general attack. It is also evident that the same smut species may attack different botanical species of oats as now recognized.

The work of observation upon the effects of local conditions, and varietal features upon the rusting of cereal grains has been continued in connection with the foregoing work upon smuts.

Under the studies upon wheat rust, isolation experiments were carried out in which grain was grown from seed to maturity under spore proof conditions, the object being to ascertain whether the Errickson theory of "symbiotic mycoplasm" is really well based for the explanation of the rust question in this country. These experiments were brought to quite a conclusive close, pointing to a negative answer. The details and results of this investigation were read before the American Association for the Advancement of Science—Boston meeting, August, 1898, and are now being published in the Centralblatt fur Bakteriologie und Parasitenkunde—Zweite Abeilung. At present there is slight hope of preventing the ravages of rust unless it be by way of extended efforts in special plant breeding. My observations indicate a good field for work along that line. The matter is, however, a very much more serious one than that indicated by the closing sentence of bulletin No. 77 of the Kentucky Experiment Station. Practically all farmers know from experience that the recommendation there made is an impossibility in effect or in practice. We must find something more definite before asking the farmer to expend hard earned money upon methods of prevention.

There have also been quite extended studies made along the line of miscellaneous plant diseases with the aim of ascertaining causes of certain minor diseases of garden and field crops, and much histological work has been done by myself and assistant to determine the exact relationship of fungus parasites to their host tissues, especially among the smuts.

As to the selection of potatoes along hereditary lines, this year's work was the fourth. A part of the seed tubers used were those from the work of the three previous years—others were selected from the hills of three pure varieties in 1897. The work seems to bear out the conclusions published in bulletin No. 30.

Much work has been done this year by way of studies upon the flora of the state, especially the grasses and forage plants, the aim being to be able to publish a preliminary flora of flowering plants, and a grass bulletin which should in a condensed form state the value of our native grasses. This work is now being prepared for publication in two separate bulletins. The one upon the flowering plants of the state is designed to constitute a list for future reference and at the same time an effort is made to state in a pointed way the economic features of the principal plants, together with matters of habits and distribution.

Outside this line of work one study in bacteriology has been kept running in the laboratory, the object of which was to ascertain the life of typhoid bacilli in milk and butter. A detailed report of this piece of work was made to the Society for the Promotion of Agricultural Science, Boston meeting,, 1898, and may be examined in the Annual Proceedings of that society. The feature of economic importance is that it was found that the bacillus of typhoid fever readily retains its vitality and multiplies in all types of milk indefinitely and persists in butter made from infected milk or cream a period of time longer than that which butter is usually kept in stock. When one takes into account the general prevalence of this most dangerous disease and the ease with which water supplies become contaminated, the importance of this knowledge is easy of appreciation. Great care should be exercised by those having the handling of milk that it does not become contaminated. The water supply used for washing cans and for other purposes within the dairy processes should of a certainty be known to be free from contamination.

There has been much demand for bacteriological analysis of drinking waters—time for which has not always been open. It is intended to do a limited amount of this work during the coming year with the view of advancing some data regarding the growth of typhoid fever in the surface well waters of the state. Of necessity this work can only arrive at results after long continued experiments and many analyses.

During the year 1898 Mr. Merton Field has been a very efficient assistant in the station work to the extent of about one-fifth time, the remainder of his work as assistant having been given to college duties.

At the present time it is impossible to keep any continuous experimental work running in the laboratories for the reason that all the rooms are occupied by various types of student work and the time of this student work breaks in upon that of the station. I earnestly hope that matters may soon so shape themselves that rooms "J" and "F" adjoining this department may be made a part of it as recommended in the Third biennial report. A separate room in which to carry on the experimental work of the spring season is a present necessity.

As chairman of the library committee I have to report that two card catalogue cases have been produced, one for the cataloging of the Agricultural Station literature, and one for the general college and station library. New shelving has been added for book space, and the work of cataloging of all books as per the Dewey system is progressing nicely.

To summarize: Four lines of work have been under more or less constant headway.:

1st. Investigations of rusts and smuts of cereal grains.

2nd. Studies of the native flora of the state.

3rd. Bacteriological investigation of the relationship of typhoid fever to dairy industry.

4th. Miscellaneous histological and mycological studies pertaining to the determination of the relationship of certain parasites to their hosts.

During the year a number of valuable books and special pieces of apparatus have been added to the working equipment of the department. We have also received a set of economic seeds prepared by the Botanical Division of the United States Department of Agriculture. This is a most valuable collection for reference purposes—500 samples in all. This supplemented by our own large collection is a most useful educational display.

Respectfully submitted,

HENRY L. BOLLEY,

Botanist.

VETERINARY DEPARTMENT.

To Director J. H. Worst:

During the last year we have been experimenting with the combined use of mallein and creolin in the treatment of glanders among horses. Apparently we have affected a cure in six subjects. Four of them were selected from an outbreak at Buffalo, North Dakota, which included seven horses. All of them showed symptoms of the disease and reacted to the mallein test, which is considered a most delicate and satisfactory means of diagnosis. Mallein has been used for this purpose both in this country and in Europe for several years, and has received the indorsements of all leading veterinarians in both countries. It bears the same relation to glanders, which tuberculine does to tuberculosis. Mallein and tuberculine are the filtered products of the bacilli of glanders and of tuberculosis in a fluid media. One c. c. of the former as sent out by the government from the Bureau of Animal Industry, injected into the cellular tissue will, in from four to eight hours, raise the temperature from three to five degrees, while the latter will act in a like manner when two c. c. are injected in the tubercular ox. Autopsies and bacteriological investigation following a reaction from either product have invariably, when carefully conducted, proven their value and their reliability as diagnostic agents.

Following the mallein test, careful post mortems were made on three of the seven horses. The leisons found were characteristic and were very generally distributed to the several organs and tissues usually invaded. Ulcers and cicatrices were found on the septeumnasi of each subject. The former had penetrated in several instances into the cartilage; had the greyish white dirty appearing bottom and elevated edge, giving them the chanerous features so well known to the practitioner, who has had to make frequent examinations of animals effected with this malady. The lungs, liver and spleen contained a large number of the glanderous nodules. One of them exhibited a farcy buds on the near hind leg, and all had nodulated enlargements of the submaxillary gland. In the four remaining horses, this gland was affected similarly, and forty-eight ulcers could be discerned upon the pituitary membranes, some of them chancerous, and quite characteristic. We are aware of the fact that inflamed and indurated lymphatic ducts and glands may occur on the surface of the body from various causes, also that the nodules in the lungs, liver and spleen may have been caused by the tubercle bacilli. But any doubt as to the nature of the malady was dispelled by the mallein test, thus placing the diagnosis beyond just

criticism, and the nature of the leisions found, beyond doubt. To still add to the evidence as to the nature of the disease, we might have resorted to the methods used by many investigators, namely, that of inoculating the guinea-pig or field-mouse with a portion of the discharge or suspected tissue thereby producing a definite line symptoms of special significance in these animals. Then we might have followed this up by a bacteriological research, making cultures of the germ, inoculating and producing the disease again in small animals, but since the outbreak had a complete history of a year's existence, together with the fact that the disease was infective and had spread from horse to horse, until all suffered from it—set aside the necessity, in our opinion, for this kind of proof. Had there been but one animal affected, then an investigation of this character would have been adopted and carried out, to verify the diagnosis and place the result of the treatment beyond question; although the mallein test is no longer doubted, providing the general and local reactions are satisfactory. These animals were injected weekly with one c. c. of government mallein and given one dram of creolin in a half pint of water, per orem, 3 times daily. They also received a rectal injection of this remedy once daily, of the strength of 1 per 100 in watery emulsion; a quart was administered each time. The average temperature after the injection of the mallein was about one degree less weekly, until the third week, when a condition of cyanosis became visible; the mucous surfaces of the nostrils and nasal chambers by their bluish tinge, gave evidence of improperly oxidized blood; this was owing to the action of the creolin. Cardiac depression was also observed at this time due to the cumulative action of certain phenoloids contained in this remedy. It must be remembered that creolin is one of the coal tar products, of the aromatic carbon series, of complex composition containing napthalin, several creosols and other phenoloids. Consequently its actions on the animal organism must be closely watched. To overcome the depression of the heart and supply oxygen to the blood, 15 grs. each of pulverized digitalis leaves, and pulverized nux-vomica, with one dram of sulphate of iron, desicated and pulverized, were given in the feed three times daily. The creolin was increased to two drams, per orem, three times daily, and the rectal injection continued. The secretion of urine was slightly increased, and the specific gravity proportionately changed, demonstrating that diruresis was normally augmented, and not due to any tissue waste. The appetite remained unimpaired. The patients were gaining in flesh. This was the fourth week and they showed decided improvement in all respects. The color of the membranes had become normal; the ulcers were healing rapidly; the enlargement of the submaxillary gland had disappeared, and there was no reaction from the use of the mallein, either general or local, except in one animal. This treatment was continued until the end of the fifth week, when all ulcers were healed, and every symptom had disappeared. The mal-

lein was now given in doses of one and a half c. c., but failed to react. The treatment was then continued until the eighth week with the exception of the mallein, the weekly injection having been omitted, it was now injected, but did not react. We then discontinued the remedies and spring work coming on, put them to work at ordinary farm service. They were kept busy till the close of the season, when one of them was destroyed and an examination made by Doctor C. H. Martin, of Buffalo, and myself. Much time was spent in this autopsy, and a careful search made for all glanderous leison. Many cicatrices were found, but few nodosities, all of which proved to be calcarious deposits. This seems to demonstrate that in the congested area about the nodosity occasioned by the action of the mallein; when succeeded by an inflamatory action, there is poured out leucocytes, coagulable lymph, and other inflamatory products, from the blood vessels to the extent that the nodosity is cast off from the normal tissues. This is the view ordinarily held to be true by investigators; but in this case if resolution begins, and it generally does, the module is absorbed and we have but a slight amount of scar tissue left in its place, as the result of tissue elements having been fortified by the antiseptic properties of the cerolin. The narcotic matter in the center of the nodule, and the contained germs, are apparantly eliminated as waste tissue. Not finding in the animal economy, in any of the adenoid glandular tissue a suitable condition for its further development, owing to the presence and effect of the antiseptic, the germ of the disease cannot again gain a foothold, and is carried helplessly by the circulation to one or the other of the outlets of the system. Just what effect the creolin has on the various tissues, and the tissue elements, remains yet to be proven. Certain it is that it quickly impregnates with its burnt penol oder, the sweat, milk and urine, by which it is eliminated from the system, partly as napthalin, and partly as sulphuric acid.

To further prove that this treatment was a success, we built a pest barn at the experimental station, and inoculated two horses with pure culture of the germ; after they had fully developed the disease, the one in the superficial acute form, and the other into the deep-seated chronic form, we gave the remedy as in the cases just described; with the exception that the full dose, namely, two drams of creolin, was administered three times daily from the start. After six weeks, no reaction could be obtained from the mallein. The post mortem in the acute case proved entirely satisfactory. The chronic subject is still at the station and will be post mortemed before the class in veterinary shortly. He has been recently tested with mallein, showing no reaction.

Three thousand doses black leg vaccine have been sent out from the station, and the reports received show that in almost every instance the vaccinated animals were rendered immune. But few

losses were reported and those were mostly very young animals, which should have been vaccinated a second time. Others in all probability, did not receive a proper dose. Several hundred doses of mallein and tuberculine were distributed to the district veterinarians for diagnostic purposes, and although a complete report has been received, no mistakes are noted.

Respectfully submitted,

W. C. LANGDON.

DEPARTMENT OF HORTICULTURE.

To J. H. Worst, Director:

The work outlined in this department for the season of 1898 was as follows:

1st. Treatment of different plats of ground with the object of preventing the appearance of cutworms.

2nd. Extending the number of varieties of small fruits grown on the station grounds, including promising wild varieties.

3rd. A trial of different standard fertilizing elements upon plants to determine the effect of these upon the total yield, quality and time of maturing as well as the specific effect of different fertilizers applied at different stages of the plants' growth.

4th. A variety test of vegetables in connection with No. 3.

5th. A test of fall vs. spring plowing for corn, beets and onions.

6th. The effect of keeping garden land covered with straw during the winter.

In addition to the work laid out I was called upon to render some assistance in several localities of the state where the Rocky Mountain locusts had appeared.

One bulletin has been prepared by this department during the year. It treats of the more prominent injurious insects of the state with methods of treatment. In this bulletin particular attention is given to the enemies of our grain fields such as the Hessian fly and Rocky Mountain locust. It also includes descriptions of and remedies for insects injurious to vegetables, fruits and shade trees. In the season of 1898 the number of cutworms in all of our trial grounds was so small as to render the results on treated plots rather uncertain. Plots that had been treated with stable manure fared the worst, while those that had been covered with straw as early as August 15th of the previous season and burned over before plowing were entirely free. Cutworms were also found rather abundantly in stable manure that had been piled up outside for compost and an application of this furnished cutworms in destructive numbers. This work will be continued in 1899 along the same lines.

For the first time fruit was obtained from plum trees grown from seed on the station grounds. This seed was from selected strains and several of the seedling trees gave fruit of unusual size and fair quality. Pits from the best strains have again been planted.

The work with fertilizers was begun under glass and continued in the open field throughout the season. As this work with the different varieties of vegetables covered about 1,300 different tests it will be impossible to give a summary of the work here. A bulletin

is now in preparation covering all the different results obtained. The marked advantage of fall plowing and the further advantage of keeping soil covered with straw during the winter were both much greater that that obtained by the use of any fertilizer as against no fertilizer. This shows that with such soil as that of the Red River Valley more depends upon how it is handled than upon any addition to its already abundant supply of plant food.

The results obtained in the variety test of vegetables carried on in connection with the work with fertilizers will be sent out in bulletin form this winter. The behavior of different varieties of the same vegetables, particularly with different strains of lettuce, when treated with different classes of fertilizers was very striking and also unexpected. While the effects of fertilizers as used in the open field was generally less than that obtained by some special manipulation of the soil, yet the marked reverse of this was true of plants in their earlier stages growing under glass. Among other differences was noted the fact that plants grown in one sort of fertilizer endured transplanting better than plants grown with a different fertilizer. Numerous other incidental observations of more or less importance were noted that will be given in their proper place.

Respectfully submitted,

C. B. WALDRON,

Horticulturist.

DAIRY DEPARTMENT.

To Director J. H. Worst:

Sir: The past year the department of dairying has continued the experiments along the line of feeding and milk production. This is a continuation of the work begun March 1st, 1897, and sufficient data has been gathered to warrant the publication of a bulletin which will appear toward the close of the present fiscal year. In addition to other feeds corn fodder and rape to supplement dry pastures was fed in August and September, and later a quantity of sugar beets was added with very gratifying results, all of which will appear in the forthcoming bulletin.

The dairy herd at present consists of four full blood Jersey cows purchased in December, 1898, and nine natives selected from purchases made at various times during the past four years.

The department has devoted the greater part of the time in dairying to the educational features rather than to the experimental, believing the best results would be obtained from such a course.

Throughout the state there seems to be a steady growth in the dairy industry, new creameries being contemplated in different parts of the state while many private dairymen are adding to their herds and purchasing hand separators for their own use. The department is striving its utmost to be of service to the dairy interests of the state, but is seriously handicapped in the work by being compelled to do a large amount of teaching in other departments of the college. The acknowledgments of the department are due to the Wells-Richardson Co. for one gallon butter color, also to Hoard's Dairyman, Chicago Dairy Produce, Creamery Journal, Creamery Gazette, Practical Dairyman, Milk Reporter, Produce Review, Elgin Dairy Reporter, Dairy World and Jersey Bulletin for copies of their valuable papers.

Respectfully submitted,

E. E. KAUFMAN.

STATEMENT.

GOVERNMENT AGRICULTURAL EXPERIMENT STATION FOR NORTH DAKOTA IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1897-8.

DEBTOR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1898, as per Act of Congress approved March 2nd, 1897	$15,000.00

CREDITOR.

By salaries	$8,423.02
Labor	2,637.89
Publications	758.95
Postage and stationery	192.49
Freight and express	170.82
Heat, light and water	236.97
Chemical supplies	133.68
Seeds, plants and sundry supplies	331.51
Feeding stuffs	351.26
Library	123.55
Tools, implements and machinery	466.74
Furniture and fixtures	111.15
Scientific apparatus	128.38
Live stock	435.00
Traveling expenses	82.67
Contingent expenses	51.55
Building and repairs	364.37
	$15,000.00

SUPPLEMENTARY STATEMENT.

DEBTOR.

To receipts from other sources than the United States for the year ending June 30, 1898	$2,648.46

CREDITOR.

By salaries	$ 240.00
Labor	1,027 26
Heat, light and water	80.50
Seeds, plants and sundry supplies	666.02
Feeding stuffs	45.85
Tools, implements and machinery	90.30
Furniture and fixtures	1.69
Contingent expenses	2.50
Balance	494.34
Total amount	$ 2,648.46

P. W. FARNHAM.